Course Code	Course Title	L	T	P	C
BACSE324	Embedded Systems Architecture	3	0	2	4
Pre-requisite	NIL	**Syllabus Version**			
		1			

Course Objectives

1. To explain embedded system constraints and relate them to design requirements and architecture.
2. To configure and program sensors, actuators, data converters and serial interfaces for reliable device integration.
3. To develop embedded software that meets resource and deadline constraints using real-time scheduling.

Course Outcomes

1. Articulate the key concepts of embedded system using various microcontrollers and interfaces.
2. Construct embedded systems by interfacing memory and I/O devices.
3. Analyze various tools to optimize the performance of the code.
4. Implement real-time scheduling strategies under resource constraints to meet deadlines and report deadline miss rates.
5. Evaluate the principles of serial communication protocols and their practical applications.

Module:1	**Introduction**	**9 hours**

Embedding Computers - Characteristics of Embedded Computing Applications - Challenges in Embedded Computing System Design - Performance of Embedded Computing Systems - Embedded System Design Process - Requirements - Specification - Architecture Design - Designing Hardware and Software Components - System Integration - Microcontroller Architecture - 8051, PIC, ARM - Case Study: IoT Board.

Module:2	**I/O Interfacing Techniques**	**9 hours**

Memory Interfacing - Analog-to-Digital and Digital-to-Analog Interfacing - Timers - Watchdog Timer - Counters - Universal Asynchronous Receiver/Transmitter (UART) - Sensor Interfacing - Pulse Width Modulation (PWM) Control of DC Motor - Stepper Motor Interfacing.

Module:3	**Programming Tools**	**8 hours**

Embedded Programming Tools - Modeling Programs: Data Flow Graph (DFG), Control Data Flow Graph (CDFG), Finite State Machine (FSM) - Code Optimization - Logic Analyzers.

Module:4	**Real Time Operating System**	**8 hours**

Classification of Real Time Systems (RTS) - Issues and Challenges in RTS - Priority-Based Scheduling -

Real Time Scheduling Schemes - Shared Resources - Embedded Configurable Operating System (eCos) and Portable Operating System Interface (POSIX).		
Module:5	**Embedded Networking Protocols and Applications**	**9 hours**
Inter-Integrated Circuits (I2C) - Controller Area Network - Embedded Ethernet Controller - RS232 - Bluetooth - Zigbee - WiFi - Embedded System Applications Using Case Studies: Agriculture Sector, Automotive Electronics, Consumer Electronics, Industrial Controls, Medical Electronics, Embedded AI Systems, Quantum Embedded Systems Architecture.		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

1. Marilyn Wolf, "**Computers as Componentsâ€“Principles of Embedded Computing System Design**", Morgan Kaufman Publishers, 5th Edition, **2022**
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "**The 8051 Microcontroller and Embedded Systems: Using Assembly and C**", Pearson, 2nd Edition, **2013**

Reference Books

1. Raj Kamal, "**Embedded Systems Architecture, Programming and Design**", McGraw Hill Education, 3rd Edition, **2015**
2. Tammy Noergaard, "**Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers**", Elsevier Science, 2nd Edition, **2013**
3. Edward Ashford Lee and Sanjit Arunkumar Seshia, "**Introduction to Embedded Systems: A Cyber Physical System Approach**", MIT Press, 2nd Edition, **2017**

Indicative Experiments

1. 8051 Microcontroller I/O operations: Embedded C programs.	4 hours
2. Design a miniature robotic arm system that uses servo motors for joint movement. The system must rotate the servo(s) to specific angles accurately (0°-180°). Angle commands can be received via manual input, sensor feedback, or serial communication (UART). The system may require smooth motion, multi-servo coordination, and position monitoring via LCD or Serial Monitor.	2 hours
3. Design a basic automated environmental control system using Arduino Uno. The system reads real-time values from sensors (e.g., temperature, light, or motion sensors). Based on sensor readings, it automatically controls actuators such as LEDs, fans, buzzers, or relays. For example: o Turn ON a fan when temperature exceeds a threshold.	4 hours

o Turn ON a light when ambient light is below a level. o Activate a buzzer when motion is detected. Sensor readings and actuator status can optionally be displayed on LCD or Serial Monitor.	
4. Design a Smart Environmental Monitoring System for a greenhouse or indoor environment. The system uses a DHT11 (or DHT22) temperature and humidity sensor to measure the ambient conditions and displays real-time values on an LCD screen. If the temperature or humidity crosses safe limits, the system can also trigger alerts (like turning ON a fan or buzzer).	2 hours
5. Designing an intelligent water tank monitoring system for a household or industrial tank. The system uses an ultrasonic sensor (HC-SR04) to measure water level and displays the real-time water level on an LCD. Additionally, the system can trigger alarms, LEDs, or pumps when water reaches critical levels (low or overflow).	2 hours
6. Design a smart obstacle detection system for a robotic vehicle or automated trolley. The system uses an ultrasonic sensor (HC-SR04) or IR proximity sensor to detect obstacles in real-time. When an obstacle is detected within a preset threshold distance, the system triggers alerts (LED, buzzer) and can optionally stop or change the direction of the vehicle. The system may also display distance readings on an LCD for monitoring.	4 hours
7. Design a smart lighting system for an office, classroom, or room.The system uses a PIR (Passive Infrared) occupancy sensor to detect human presence. When the sensor detects someone entering the room, the lights automatically turn ON. When no motion is detected for a preset time, the lights automatically turn OFF. Optionally, the system can display occupancy and light status on an LCD or Serial Monitor for monitoring and debugging.	4 hours
8. Design a smart parking system for a parking lot or garage. The system uses ultrasonic sensors, IR sensors, or proximity sensors to detect the presence of vehicles in parking slots. The system can monitor available and occupied slots in real-time. Display the number of available slots on an LCD or seven-segment display. Optionally, control entry/exit barriers or LED indicators for occupied/free slots. This helps in efficient parking management and reduces human intervention.	4 hours
9. Case studies based real-time implementation.	4 hours
Total Laboratory Hours:	**30 hours**

Mode of Evaluation: Continuous Assessment Test, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Presentation, Course Project, Case Study	
Recommended by Board of Studies :	16-10-2025

Approved by Academic Council : No. 80	20-11-2025